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Smoke Alarms and Carbon Monoxide Alarms in Households With Children, Puerto Rico, 2010

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Abstract

In 2017, Puerto Rico sustained extensive damage from Hurricane Maria, increasing the risk of fires and carbon monoxide (CO) poisonings. Using a population-based, in-person survey of households with children less than 6 years old in Puerto Rico, we collected data in 2010 concerning the presence of smoke alarms and CO alarms in these households. We generated national estimates by extrapolating the number of households in each stratum using data from the 2010 Census. We determined which household characteristics predicted the presence of these alarms. Of 355 households analyzed, 31% had functional smoke alarms, or an estimated 109,773 households territory wide. The presence of smoke alarms was associated with living in multifamily housing and no child in the household receiving government medical insurance. Public housing or publicly subsidized housing, as compared to owner-occupied housing and unsubsidized rental housing, was associated with having a functional smoke alarm in households with children aged less than 6 years. Based on only six houses having CO alarms, we estimated only 7685 (2%) households had CO alarms. The low prevalence of functional smoke or CO alarms 7 years before Hurricane Maria is unfortunate and should be remedied by ensuring that such alarms are widely installed in current rebuilding activities.

Introduction

When operational and placed correctly, smoke alarms are an inexpensive form of primary and secondary prevention. Smoke alarms can lower the risk of death from residential fires by 50% or more, as well as reducing the risk of fire- and smoke-associated injuries (Marshal et al., 1998). In the 2001–2003 Second Injury Control and Risk Survey, an estimated 95% of

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all U.S. households had smoke alarms (Ballesteros & Kresnow, 2007). If smoke alarms were used by 100% of all households, an estimated 30% of U.S. residential fire deaths could be prevented (Aherns, 2019).

As with smoke alarms, carbon monoxide (CO) alarms are effective prevention for CO poisoning (Bronstein et al., 2011). In the United States during 2000–2009, an estimated 400 deaths and 15,000 emergency department visits occured annually because of unintentional, non-fire-related CO poisonings (Bronstein et al., 2011). The annual average, age-adjusted CO-related death rate in the United States during 1999–2012 was 1.5 per million (Sircar et al., 2015). However, relatively few homes in the United States have CO alarms. In 2007 (the most recent data available), only 30% of all U.S. households were estimated to have a CO detector (Runyan et al., 2005; U.S. Department of Housing and Urban Development, 2008).

Accidental CO poisonings usually occur during or after severe storms (Harduar-Morano & Watkins, 2011). Puerto Rico is prone to tropical storms and hurricanes, which increase the use of generators and other sources of CO emissions. Smoke and CO alarms may be especially important under these conditions. In this study—conducted 7 years before Hurricane Maria—we examined the prevalence of smoke alarms and CO alarms and the factors that predicted their presence in households with children less than 6 years old in 2010.

Methods

Data Collection

In 2010, we conducted a population-based, cross-sectional study primarily to determine the prevalence of blood-lead concentrations among children less than 6 years old (Dignam et al., 2016). Ten data collection teams collected data during the 6-week study (4 weeks in June and July and 2 weeks in November). Each team comprised at least one Puerto Rican Department of Health staff member, one Centers for Disease Control and Prevention (CDC) staff member or one Puerto Rican Department of Health-trained field epidemiology fellow, one health care professional, and one community member. Team members were trained in cultural sensitivity, data collection, capillary and venous blood drawing, environmental sampling, referrals, and personal safety. At least two team members were fluent in Spanish.

Trained interviewers administered an in-home survey that included a household questionnaire, a child questionnaire, a healthy home questionnaire, and environmental observations (e.g., interviewers inspected the house for evidence of water damage or mold). Respondents were also asked whether the household had smoke alarm(s) or CO alarm(s). Potential responses to both questions were: yes, there is at least 1 working alarm; yes, there is an alarm, but it does not work; or no, there is no alarm. Field team members assessed the functionality of the smoke alarm and CO alarm, if present. The interviewer recorded the presence and functionality of smoke alarms and CO alarms.

The study methods are described elsewhere (Dignam et al., 2016). Briefly, we used a two-stage random sample to enroll a representative sample of Puerto Rican families who had at least one child less than 6 years old. Participants were invited to join the study through a

door-to-door survey. In the primary study, we reported weighted percentages based on the 2000 U.S. Census that represented the total number of households with children less than 6 years old living in Puerto Rico (U.S. Census Bureau, 2000). We sampled 40 clusters (i.e., census tracts) by using a probability proportional to the 2000 Census. We sampled households randomly (i.e., varied by day of the week and time of day) within selected clusters without known bias. At least three visits were required for each household selected before a determination was made.

Risk Factors

We examined risk factors that might be associated with whether a household had a smoke or CO alarm. We obtained information on risk factors from the head of the household as reported in the child and household questionnaires. For the data analysis, we grouped data on type of home ownership into the following discrete categories: (1) owner-occupied, (2) unsubsidized rental, (3) public housing, (4) publicly-subsidized housing, (5) other, and (6) no response. The public and publicly subsidized housing categories included government-supported public housing and Section 8 voucher-assisted rental housing (i.e., housing subsidized under 42 U.S. Code [USC] Sections 1437 [The Public Health and Welfare-Declaration of Policy and Public Housing Agency Organization, 2010a] and 1437f [The Public Health and Welfare-Low-Income Housing Assistance, 2010b], respectively). We grouped data on type of household dwelling into the following categories for analysis: single-family household, multifamily household, apartments with two or more units, other, and no response. A multifamily household was an address with multiple families under one roof. A family unit was a parent or guardian with at least one child less than 6 years old.

We also assessed other variables, including resident smoking status (based on a yes/no response to the question, “Does anyone smoke tobacco inside the home?”), the presence of a generator or fuel-burning device anywhere on the property (yes/no), renovation activity in the household during the previous 6 months (yes/no), mother’s education level [none, eighth grade, high school graduate or general educational diploma (GED), trade school, or any college], the presence of pets in the household, whether the child had government-issued medical insurance (i.e., Reforma/Mi Salud), whether any of the children in the family had ever received food stamps (yes/no), whether any of the children had ever received public housing assistance (yes/no), whether the children had ever received a Section 8 voucher (yes/no), and whether the children had ever received Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) services (yes/no) or any other form of child public assistance (yes/no). Because only six households reported having CO alarms, we excluded CO alarms as an outcome from the risk factor analysis.

Statistical Analysis

We analyzed data on the predictive factors in relation to the outcome variable (i.e., the presence of a functional smoke alarm). To calculate prevalence estimates and make inferences about all households with children less than 6 years old, we created sampling weights to account for any unequal selection probabilities, to account for nonresponse, and to calibrate to the 2000 U.S. Census population by child age. To obtain a more accurate estimate for the current report, we post-stratified the weights with population estimates by

age categories from the 2010 U.S. Census. The number of households with children less than 6 years old was estimated by summing the sampling weights. We conducted a population-weighted Pearson $\chi 2$ test of independence to evaluate the association between each predictive factor and the presence of a functional smoke alarm. We report weighted percentages with 95% confidence intervals (CIs).

We used unadjusted and multivariable, weighted logistic regression to identify which, if any, of the risk factors listed above were associated with the presence of a functional smoke alarm. All predictive variables of interest were first fit into a weighted logistic model. We used a chunk test to identify predictive factors to be included in the final model. The chunk test uses an aggregate $\chi 2$ test that allowed several variables to be assessed in a single test. We only included significant variables in the final model; alpha was set at 0.05. We reported adjusted weighted odds ratios (ORs) and 95% CIs for predicting the presence of a functional smoke alarm. Missing data were excluded from multivariable analyses and no outliers were removed.

Data were analyzed with SAS the statistical software program, version 9.3 (SAS Institute Inc., Cary, NC). The complex procedures of incorporating sample weights, clustering, and stratification were performed with SUDAAN version 11.0 (Research Triangle Institute, Research Triangle Park, NC). The Institutional Review Boards at the CDC and the Puerto Rican Department of Health approved the study.

Results

Of the 1397 households visited, 855 (61.2%) were ineligible (i.e., there were no children less than 6 years old, the residence was unoccupied, or the address was not a residence); 136 households appeared occupied, but field team members did not find anyone at home after at least three visits; and 29 occupants declined to participate, leaving 377 (69.6%) eligible households. After removing 22 households with children who did not have blood collected from the original study (and thus no housing characteristics were collected for the present study), the analytic data set consisted of 355 households with at least one child less than 6 years old.

Among all 358,793 Puerto Rican households with at least one child less than 6 years old, an estimated 109,773 (30.6%) had functional smoke alarms and an estimated 7685 (2.3%) had functional CO alarms (see Table 1). By type of ownership, an estimated 21.8% of owner-occupied households, 23.7% of unsubsidized rental households, and 86.6% of public or publicly subsidized households had functional smoke alarms ($p < 0.001$). By type of dwelling, an estimated 23.8% of single-family households, 63.6% of two- or three-unit apartments, and 71.8% of multifamily households had functional smoke alarms ($p < 0.001$; see Table 2).

In the unadjusted analysis, type of ownership, type of dwelling, a child ever receiving public housing assistance, and a child ever living in Section 8 housing were all significantly associated ($p < 0.001$) with the presence of a functional smoke alarm. Type of ownership, type of dwelling, and government-issued medical insurance for a child remained significant

in the multivariable analysis (see Table 3). The odds of multifamily households having a functional smoke alarm were six times as high as that for single-family households (OR, 6.60). Public housing or publicly subsidized housing had 25 times higher odds of having a functional smoke alarm than owner-occupied households (OR, 25.0). Similarly, residents of public housing or publicly subsidized housing had 20 times higher odds of having a functional smoke alarm than unsubsidized rental households (OR, 19.6). The odds of having a functional smoke alarm were four times (OR, 4.0) higher for families without a child who ever received government-issued medical insurance than for families with a child who ever received government-issued medical insurance (see Table 4). Finally, apartments with two or more units had 1.6 times higher odds of having a functional smoke alarm than single-family households (OR, 1.55); however, this estimate was not significant (data not shown).

Discussion

We estimated that only 32% of households in Puerto Rico with children less than 6 years old had functional smoke alarms in 2010, a percentage much lower than a 2003 U.S. survey-based national estimate of 95% (Ballesteros & Kresnow, 2007). Although not directly comparable, in the U.S. estimate, the prevalence of a smoke alarm among renters (94%) was much higher than our estimate for Puerto Rico (23.7%). However, the true prevalence may be lower because the U.S. survey relied on self-reports, which may be subject to social desirability bias. A review of 16 studies in the U.S. found that the prevalence of smoke alarms in high-risk communities (residents with children, older adults, people with disabilities, and those living in poverty, substandard housing, or rural areas) ranged from 34 to 78%; all much lower than in national U.S. estimates (Liu, Holland, Mack, & Diekman, 2011).

In our study, the odds of having a functional smoke alarm were 29 times higher in public housing or publicly subsidized housing than in owner-occupied housing, and 26 times higher in public housing or publicly subsidized housing than in unsubsidized rental housing. This difference is likely because the U.S. Department of Housing and Urban Development (HUD), which supports public housing, directly, and assisted housing, through subsidies, requires smoke alarms in public and assisted rental units (U.S. Department of Housing and Urban Development, 1993, 2005). Because Puerto Rico is a U.S. Territory and subject to the same regulatory oversight, this requirement is enforceable for public housing by the Puerto Rican Public Housing Administration, which owns and operates public housing projects with HUD funds (The Public Health and Welfare-Contract Provisions and Requirements, 1998). Although we did not study the direct link between HUD funding and smoke alarms, our results are consistent with the successful implementation of these HUD requirements. Puerto Rican law also requires that smoke alarms be installed in residential dwellings (Commonwealth of Puerto Rico Regulations and Permits Administration, 1999). However, we found a low prevalence of alarms in residential dwellings, indicating that this requirement had not been widely met by 2010.

In our study, living in multifamily housing, compared with living in a single-family household, predicted a greater prevalence of functional smoke alarms. The reason for this finding is unclear. A 2005 survey in nine states and Puerto Rico reported that the distribution

of safety education material, especially through children, influenced home safety behavior (e.g., in families who had smoke alarms) (Kourofsky & Cole, 2010). We hypothesized that households with multiple children and families might have an increased opportunity for home safety behavior, such as having a functional smoke alarm because children are an important link between talking about safety education and implementing home safety. Multifaceted interventions, such as education, provision of low-cost or free equipment, and provision of home safety inspections, are considered most effective for increasing the prevalence of functional smoke alarms and can be considered as Puerto Rico rebuilds (Cooper et al., 2012).

The presence of a functional smoke alarm was significantly ($p < 0.05$) lower among households with any children who had ever received government medical insurance (i.e., Reforma/Mi Salud). In several U.S. studies, low household income was associated with a lower prevalence of smoke alarms (Ballesteros & Kresnow, 2007; Harvey, Sacks, Ryan, & Bender, 1998; Smith, 1994). For example, although somewhat dated, a report from a 1992 national survey on smoke detector operability showed that households with less than $15,000 in annual income accounted for 33% of all households without at least one functional smoke alarm and only 23% of households with functional smoke alarms (Smith, 1994). The 2011 estimated median household income in Puerto Rico was $18,660, much less than the 2011 U.S. median income of $50,054 (DeNavas-Walt, Proctor, & Smith, 2012; Noss, 2012).

In 2007, fire-related fatality rates in the United States were among the highest in the developed world, although 96%−97% of households surveyed in 2008 and 2010 by the National Fire Protection Association (NFPA) reported having at least one functional smoke alarm (Aherns, 2019; U.S. Fire Administration, 2011). This information highlights the complex nature of effective fire prevention. Apart from the presence of a functional, hard-wired smoke alarm, many smoke alarms require batteries as back-up when electricity fails. The National Fire Protection Association reported during 2009–2013 that the main reasons smoke alarms did not sound in a fire (enough to trigger an alarm) were because of missing or disconnected batteries (46% of the time) or because of a dead battery (24% of the time; Aherns, 2019). Because many hazardous conditions occur during a power outage, the CDC recommends replacing batteries in battery-operated smoke alarms and CO alarms yearly and testing the operation of smoke alarms and CO alarms monthly (Slack & Heumann, 1997). In addition, residents should replace smoke alarms every 10 years and have a family fire escape plan (Ballesteros & Kresnow, 2007; U.S. Fire Administration, 2016).

Having a functional CO alarm in the household can reduce fatal and nonfatal CO poisonings (Lavonas et al., 2004; Yoon, MacDonald, & Parrish, 1998) and has a high benefit-to-cost ratio (Ran, Nurmagambetov, & Sircar, 2017). However, only 2% of the households in Puerto Rico with children less than 6 years old were estimated to have a CO alarm. (In the United States, the proportion ranged from 29 to 68% in 2002; Runyan et al., 2005; U.S. Department of Housing and Urban Development, 2008). In Puerto Rico, the risk for CO poisoning from generator use during and after storms is potentially greater than that in mainland United States (U.S. Consumer Product Safety Commission, 2014). Gasoline-powered generators used inside or too close to the home, basement, or garage can expose residents to CO.

However, in Puerto Rico, in 2018, we were not able to identify any CO alarm regulations. From our study, the extent to which household generators or other fuel-burning devices were used in Puerto Rico was likely small because of the low number of residents reporting generator usage. Although our findings estimated that 34,000 (9%) households with children less than 6 years old were using such fuel-burning devices, further study is warranted.

We briefly discuss U.S. regulation and research about CO alarms because it is what is available and because of the lack of information about Puerto Rico. Many states have laws and regulations related to building, remodeling, and selling a dwelling that require installing CO alarms. Building codes, including the International Building Code (International Code Council, 2017), the National Fire Protection Association Fire Code (National Fire Protection Association, 2018), and international fire codes (International Code Council, 2018), also guide new housing construction and remodeling. Such standards cover owned and rented housing, including multi-unit complexes and single-family dwellings. Smoke alarms are more widely supported than are CO alarms across states, but CO alarm standards are not always required and vary from state to state. As of 2018, statutes in the District of Columbia and 27 states required CO detectors in private dwellings, and 11 states required CO detectors in private dwellings through the adoption of the International Residential Code or an amendment to the state's building code (National Conference of State Legislatures, 2018). Regional estimates of presence of a CO alarm vary: in a survey from Seattle, Washington, and Salt Lake City, Utah, 678 of 1351 (50.2%) respondents reported having a CO alarm in their home (Hampson & Weaver, 2011). In a 2009 survey in Mecklenburg County, North Carolina, 145 of 214 (68%) respondents reported having a functional CO alarm in their home (Iqbal et al., 2012). Our findings show a much lower usage of functional CO alarms in Puerto Rico. In both the U.S. and Puerto Rico, HUD does not require CO alarms in properties it subsidizes (personal communication, W. Friedman, HUD, July 20, 2017).

Although our findings are dated, they should be especially relevant today because they indicate a historically low rate of preparedness for coping with the daily risks of fire and CO poisoning as well as with the elevated risks caused by severe storms. In addition, recovery efforts after Hurricane Maria should take the opportunity to install these alarms in new and renovated structures throughout the island. Our data results were shared with the Puerto Rican state epidemiologist shortly after data analyses were completed.

Strengths and Limitations of the Study

This study had several limitations. The most obvious limitation is that the data are 9 years old and the housing stock in Puerto Rico sustained heavy damage during Hurricane Maria. However, we believe that publishing these data now calls attention to the formerly low prevalence of these alarms and thus encourage their installation during rebuilding.

We were not able to assess possible differences between families who did and did not participate in the study because we did not survey non-respondents. As such, our results could potentially have been adversely affected by selection bias. We also did not ask how often smoke alarm and CO alarm batteries were replaced, whether every level of the residence had a functional smoke alarm, and whether the family had a fire evacuation plan. These answers would more comprehensively assess the resident's ability to respond to a

home fire or CO exposure. We did not ask about the year in which the survey respondent's house was built, an important predictor of the presence of smoke alarms, but not of CO alarms [personal communication, W. Friedman, HUD, July 22, 2019, based on the 2011 American Housing Survey (U.S. Bureau of the Census, 2015)]. Older homes may be less likely than newer homes to have comprehensive fire prevention components (Sidman, Grossman, & Mueller, 2011). In half of the areas we sampled in our survey, more than 20% of dwellings were built before 1950 (Dignam et al., 2016). That said, the strengths of our study were its nationally representative sample, trained data collectors, and vigorous efforts to contact eligible residents.

Conclusions

Our results indicate that, in 2010, 7 years before Hurricane Maria, only about a third of households with children less than 6 years old had functioning smoke alarms, a percentage well below that in the U.S. mainland and clearly inadequate given the increased risk of fires after severe storms. These households also might have been at increased risk for CO poisoning from generator use during and after storms. These findings underscore the importance of installing smoke alarms and CO alarms into rebuilt and new dwellings even three years after the terrible destruction on the island caused by Hurricane Maria.

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Table 1:

Selected Household Characteristics Enrolled in the Blood Lead Prevalence Study, Puerto Rico, 2010 (N=355)

Household characteristic	Unweighted Number (%) N=355	Weighted Number, Percent (95% Confidence Interval) N=358,793
Functional Smoke Alarm		
Yes	120 (33.8)	109,773, 32.2 (21.8–42.6)
No	209 (58.9)	213,110, 62.5 (51.9–73.2)
Yes, but not functional	13 (3.7)	17,955, 5.3 (0.5–10.0)
Missing response	13 (3.7)	--
Functional Carbon Monoxide Alarm		
Yes	6 (1.7)	7,685, 2.3 (0.0–5.7)
No	336 (94.7)	332,954, 97.7 (94.3–100)
Missing response	13 (3.7)	--
Ownership Type		
Owner occupied	137 (38.6)	156,046, 45.5 (33.5–57.5)
Unassisted rental	77 (21.7)	82,399, 24.0 (13.3–34.8)
Public housing	62 (17.5)	41,542, 12.1 (0.0–25.4)
Publicly subsidized	23 (6.5)	19,153, 5.6 (1.1–10.1)
Other	44 (12.3)	43,646, 12.7 (7.2–18.3)
Missing response	12 (3.3)	--
Dwelling Type		
Single family household	231 (65.1)	242,713, 70.8 (53.4–88.2)
Multiple-family household	30 (8.5)	14,418, 4.2 (0.0–9.2)
Two-unit apartment (duplex)	24 (6.7)	41,683, 12.2 (0.0–25.8)
>Two-unit apartment (duplex)	47 (13.2)	36,489, 10.6 (0.0–23.4)
Other	11 (3.1)	7,482, 2.2 (0.0–5.2)
Missing response	12 (3.3)	--
Form of Public Assistance (respondent could choose >1 response)		
Government medical insurance (Reforma)	275 (77.5)	258,365, 73.1 (60.6–85.5)
Public housing assistance	72 (20.3)	35,014, 9.9 (4.1–15.8)
Section 8 voucher	34 (9.6)	30,956, 8.8 (2.2–15.3)
Receipt of food stamps	236 (66.5)	234,982, 66.5 (60.6–85.5)
Woman, Infants and Children (WIC)	268 (75.5)	258,120, 73.0 (63.7–82.3)
Mother level of education		
< High School Graduate or GED	64 (18.0)	44,389, 12.8 (7.6–17.9)
High School Graduate or GED	286 (80.6)	30,230, 87.2 (82.1–92.4)
Missing response	5 (1.4)	1.7, 5,982 (0–3.6)
Exterior of Dwelling		
Brick	1 (0.3)	--

Household characteristic	Unweighted Number (%) N=355	Weighted Number, Percent (95% Confidence Interval) N=358,793
Cement or cement blocks	316 (89)	324,535, 95.0 (91.8–98.2)
Wood	14 (3.9)	8,118, 2.4 (0.0–5.0)
Cement; Siding	1 (0.3)	--
Cement; Wood	10 (2.8)	6,839, 2.0 (0.6–3.9)
Other	2 (0.6)	--
Missing response	11 (3.1)	--
Household renovated during previous 6 months (inside or outside)		
Yes	64 (18.0)	60,135, 17.7 (10.0–25.4)
No	271 (76.3)	273,259, 80.6 (72.5–88.7)
Don’t know	5 (1.4)	5,631, 1.7 (0.0–3.5)
Missing response	15 (4.2)	--
Smoke tobacco inside the household (includes hanging tobacco products out the window)		
Yes	47 (13.2)	48,947, 14.2 (8.2–20.2)
No	298 (83.9)	296,110, 85.8 (79.8–91.8)
Missing response	10 (2.8)	--
Evidence of car repair or work on machinery in the yard		
Yes	51 (14.4)	49,993, 14.6 (6.0–23.2)
No	294 (82.8)	292,254, 85.1 (76.5–93.7)
Don’t know	1 (0.3)	--
Missing response	9 (2.5)	--
Household generator or other fuel burning device that uses natural gas, propane, wood, diesel, or coal		
Yes	32 (9.0)	33,928, 9.9 (4.1–15.8)
No	310 (87.3)	307,602, 90.1 (84.2–95.9)
Missing response	13 (3.7)	--

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Table 2:

Selected Household and Personal Characteristics by Functional Smoke Alarm Status, Puerto Rico, 2010

Household or Personal Characteristic	Presence of Functional Smoke Alarm (weighted %, 95% confidence interval)*		Chi square p-value***
Ownership type	**Yes**	**No**	
Owner occupied	21.8% (10.1%–33.5%)	78.2% (66.5%–89.9%)	
Unassisted rental	23.7% (8.8%–38.6%)	76.3% (61.4%–91.2%)	<0.001
Public/publicly subsidized housing	86.6% (68.2%–100%)	13.4% (0%–31.8%)	
Other	--	--	
Missing response	--	--	
Dwelling type	**Yes**	**No**	
Single family household	23.8% (15.6%–31.7%)	76.3% (68.3%–84.4%)	
Multiple-family household	71.8% (60.6%–83.1%)	28.2% (16.9%–39.4%)	
Two-unit or > two-unit apartment (duplex)	63.6% (34.4%–92.7%)	13.4% (7.3%–65.6%)	<0.001
Other	--	--	
Missing response	--	--	
Any form of public assistance (child)	**Yes**	**No**	
Yes	30.2% (18.3%–42.1%)	69.8% (57.9%–81.7%)	0.06
No	50.3% (32.8%–67.9%)	49.7% (32.1%–67.2%)	
Government medical insurance (Reforma) (child)			
Yes	30.3% (17.3–43.0)	69.7% (57.0–82.5)	0.33
No	39.2% (24.4–54.0)	60.8% (46.0–75.6)	
Public housing assistance (child)			
Yes	83.0% (59.1–100)	17.0% (0–40.9)	<0.001
No	27.0% (18.9–35.2)	73.0% (64.8–81.1)	
Section 8 voucher (child)			
Yes	88.6% (73.7–100)	11.4% (0–26.3)	<0.001
No	27.8% (16.3–39.4)	72.2% (60.6–83.7)	
Receipt of food stamps (child)			
Yes	31.6% (19.0–44.2)	68.4% (55.8–81.0)	0.66
No	35.0% (22.0–48.1)	65.0% (51.9–78.0)	
Women, Infants and Children (WIC) (child)			
Yes	30.2% (15.5–44.9)	69.8% (55.1–84.5)	0.51
No	38.5% (20.6–56.5)	61.5% (43.5–79.4)	
Smoke tobacco** **inside the household (includes hanging tobacco products out the window)**	**Yes**	**No**	0.09
Yes	51.3% (25.5%–77.2%)	48.7% (22.8%–74.5%)	
No	29.8% (18.9%–40.7%)	70.2% (59.3%–81.1%)	
Household generator or other fuel burning device that uses natural gas, propane, wood, diesel, or coal	**Yes**	**No**	0.37

Household or Personal Characteristic	Presence of Functional Smoke Alarm (weighted %, 95% confidence interval)*		Chi square p-value***
Yes	21.8% (1.1%–42.4%)	78.2% (57.6%–98.9%)	
No	34.3% (22.0%–46.6%)	65.7% (53.4%–78.0%)	
Household renovated during previous 6 months (inside or outside)	**Yes**	**No**	0.19
Yes	22.7% (5.4%–39.9%)	77.3% (60.1%–94.6%)	
No	36.5% (24.4%–48.6%)	63.5% (51.4%–75.6%)	
Mother level of education	**Yes**	**No**	
< High School Graduate or GED**	30.2% (19.7%–40.7%)	69.8% (59.3%–80.3%)	0.21
High School Graduate or GED	41.3% (20.1%–62.6%)	58.7% (37.4%–79.9%)	
Presence of pets in the household	**Yes**	**No**	
Yes	27.0% (14.0%–39.9%)	73.0% (60.1%–86.0%)	0.15
No	41.2% (24.4%–58.0%)	58.8% (42.0%–75.6%)	
Number of residents living in the household	**Yes**	**No**	
2	23.6% (0%–47.9%)	76.4% (52.1%–100%)	
3	36.1% (20.6%–51.5%)	63.9% (48.5%–79.4%)	0.21
4	29.6% (11.9%–47.4%)	70.4% (52.6%–88.1%)	
5	45.1% (26.4%–63.8%)	54.9% (36.2%–73.6%)	
≥ 6	19.7% (2.7%–36.8%)	80.3% (63.2%–97.3%)	
Number of children in the household <14 years old	**Yes**	**No**	
1	25.2% (14.4%–35.9%)	74.8% (64.1%–85.6%)	
2	37.7% (21.9%–53.5%)	62.3% (46.5%–78.1%)	0.22
3	42.6% (21.4%–63.7%)	57.4% (36.3%–78.6%)	
≥ 4	22.5% (0%–45.3%)	77.5% (54.7%–100%)	

* missing responses excluded

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*** Using Pearson $\chi 2$ test; $p < 0.05$ was considered significant

**** Includes hanging tobacco products out the window

Table 3:

Chunk test results of nine predictive variables of a functional smoke alarm, Puerto Rico, 2010

Analysis of Effects			
Effect	**DF***	**Wald Chi-Square**	**p-value**
Ownership type	2	22.0673	<0.0001
Dwelling type	2	9.6593	0.0080
Smoke tobacco ** **inside the household (includes hanging tobacco products out the window)**	1	1.4507	0.23
Household renovated during previous 6 months (inside or outside)	1	1.1675	0.28
Household **generator or other fuel burning device that uses natural gas, propane, wood, diesel, or coal**	1	0.0051	0.94
Mother level of education	1	0.8901	0.34
Presence of pets in the household	1	1.7315	0.19
Receipt of food stamps	1	0.0159	0.90
Government medical insurance (Reforma)	1	4.3418	0.03

* DF=degrees of freedom

** Includes hanging tobacco products out the window

Table 4:

Predictors of functional smoke alarms in Puerto Rican homes, 2010

Predictors			
Effect	**Point Estimate**	**95% Wald Confidence Limits**	
Public housing or publicly subsidized housing versus Owner-occupied	25.0	6.3	100.0
Public housing or publicly subsidized housing versus unsubsidized rental	19.6	4.6	100.0
Multiple-family household versus single family household	6.6	1.9	22.5
Two-unit or > two-unit apartment versus single family household	1.6	0.4	6.0
No child ever on government issued medical insurance (Reforma/Mi Salud) versus any child ever on government issued medical insurance (Reforma/Mi Salud)	4.0	1.6	10.0